

Cytomorphological investigations of some species of the genus *Cassia* L. in Nigeria

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Summary : Chromosome numbers of 18 specimens (13 species) of the genus *Cassia* are determined for the first time from Nigeria. 9 of the 13 species are non native ; 7 are diploids and 6 are tetraploids. The haploid number of 11 for *C. marginata* seems to be a new report. A new base number of 9 has been added to the already known base numbers of 6, 7, 8, 11 and 13. B-chromosomes in *Cassia* are reported for the first time (*C. hirsuta*, $n = 8 + 1B$; *C. podocarpa*, $n = 8 + 1B$). The results obtained from Nigeria are compared with the available data from other countries. Seed morphology of 11 species of *Cassia* is described.

Résumé : Les nombres chromosomiques de 18 spécimens du Nigeria (13 espèces) du genre *Cassia* sont donnés pour la première fois ; 9 de ces espèces sont introduites ; 7 sont diploïdes, 6 sont tétraploïdes. Le nombre haploïde de 11, chez *C. marginata*, semble n'avoir encore jamais été donné. Le nombre de base de 9 est ajouté à la série des nombres de base déjà connus (6, 7, 8, 11 et 13). La présence de B-chromosomes est signalée pour la première fois chez *Cassia* (*C. hirsuta*, $n = 8 + 1B$; *C. podocarpa*, $n = 8 + 1B$). Les résultats trouvés pour le Nigeria sont comparés aux données obtenues dans d'autres pays. La morphologie de la graine de 11 espèces de *Cassia* est décrite.

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INTRODUCTION

Cassia is a large genus of 500-600 species (WILLIS, 1973), distributed in tropical and warm temperate regions of the world. It is characterized by having even pinnate leaves and many leaflets, showy flowers in axillary and terminal panicles, stamens 10 and unequal, some frequently reduced to staminodes. In West Africa, it is represented by 22 indigenous species and many aliens are grown for decorative purposes. Many species yield commercial timber.

Cassia has been comprehensively investigated in the Indian subcontinent (BIR & SIDHU, 1967 ; BIR & KUMARI, 1977 ; PANTULU, 1960 ; MEHRA & HANS, 1971 ; MEHRA & SAREEN, 1973 ; SAREEN & PARTAP, 1975 ; TANDON & BHAT, 1970). In United States, this genus has been cytologically surveyed by IRWIN & TURNER (1960). Reports on the chromosome numbers of *Cassia* spp. from West Africa are meagre (MANGENOT & MANGENOT, 1962 ; MIÈGE, 1962). A comprehensive attempt to study the cytomorphology of the West African species of *Cassia* is still lacking. The present study is a part of the Senior author's project on the biology of the Nigerian Leguminous plants. The cytology of 18 specimens (13 species) and the seed morphology of 11 species are reported here.

MATERIAL AND METHODS

The materials were collected from the environs of Benin City. The young flower buds were fixed in 1 : 3 acetic alcohol for 12 hours and then transferred into 70 % ethyl alcohol and stored in the refrigerator until needed, Meiotic and Mitotic preparations were made using techniques outlined by GILL (1970, 1971). About 40-50 well spread metaphase and anaphase cells were analyzed. Camera lucida drawings were made from the permanent slides. Pollen fertility was determined following GILL (1979). For pH determination, the soil samples were taken from the exact site of the plant material and the pH of the soil was determined using techniques described by CHAPMAN (1976) and using Phillips PW 9418 pH meter.

The seed outlines were drawn by projecting the seed with an overhead projector and the details of the seed coat were filled in by examining the seed under a dissecting stereoscopic microscope and a magnifying lamp, each equipped with a fluorescent light. The terminology used for describing the seed morphology was given by CORNER, 1976. Fifty mature pods for each species were measured and each pod was opened to count the number of seeds. Mean and standard error were calculated both for pod length and seed production. The voucher specimens and seed samples are deposited in the herbarium of the University of Benin, Nigeria.

OBSERVATIONS

The exact locality accession numbers, chromosome numbers and ploidy level of the 18 specimens are given in Table 1. Table 2 summarizes the phenological data of the investigated species. The species are arranged alphabetically.

***Cassia alata* L.**

An introduced shrub about 3-4 m high with large paripinnate leaves and orange coloured rachis, golden yellow flowers in terminal inflorescence. Occurs near settlements and waters in acidic soils with pH as low as 5.

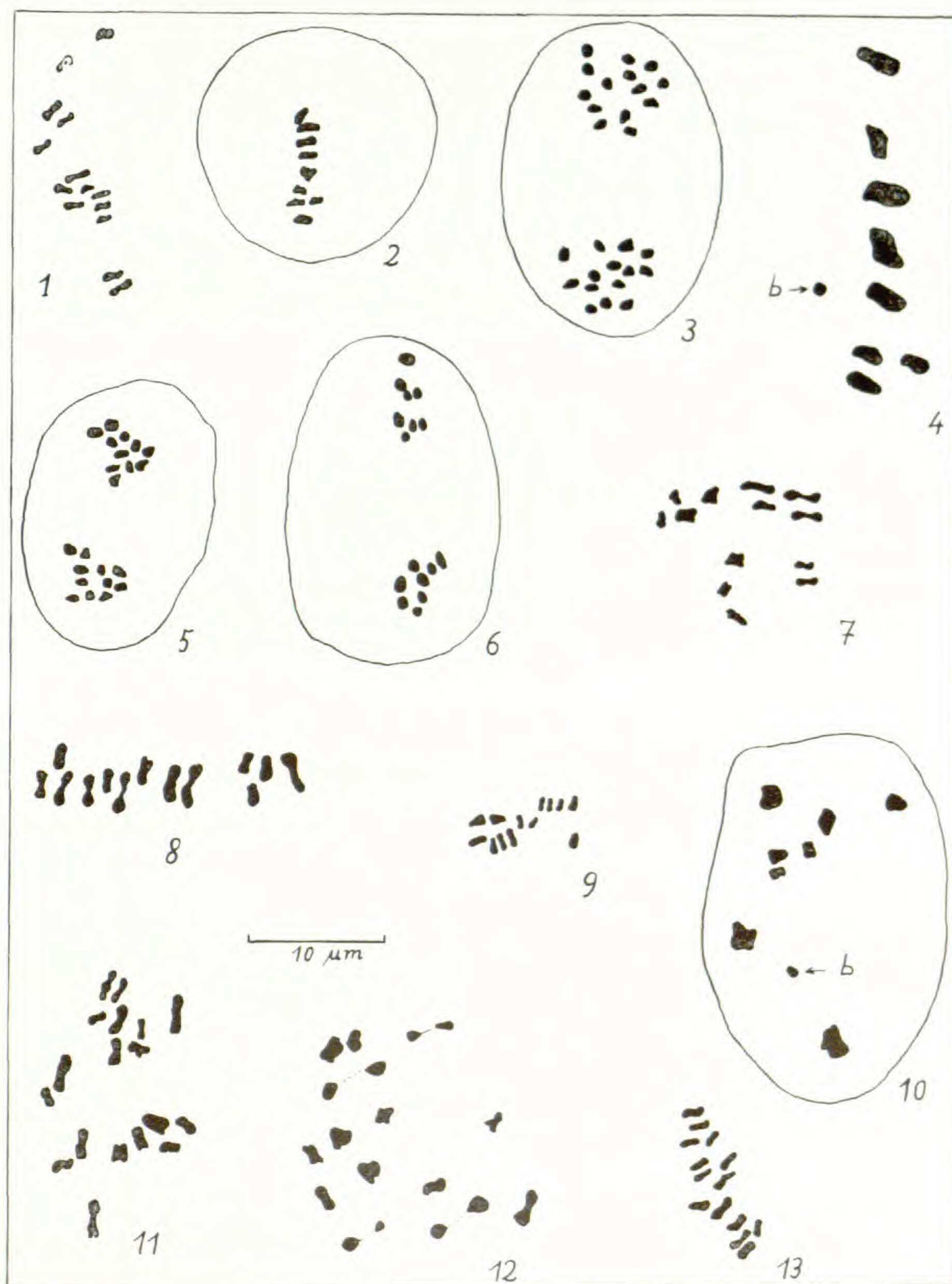
Meiosis is normal with $n = 14$ (Pl. 1, 1). The % of filled pollen is 98 and average grain size is 32.25 μm .

Seed morphology (Pl. 2, 5) : Seed dull brown to black ; not puckered or pitted ; triangular, elliptical, compressed, raphe absent, $7 \times 5 \times 2$ mm ; seed coat smooth, thin and tough ; prominent lengthwise ridge demarcates seed into two ; hilum small, apical notch present.

***Cassia bicapsularis* L.**

An alien from tropical America and widely cultivated as hedge plant in West Africa. A shrub about 2-3 m high with yellow flowers in axillary racemes. It thrives well in neutral or alkaline soil with pH range of 7.2-7.6.

A haploid number of 9 at M-I (Pl. 1,2) was counted. The filled pollen is 98 %. The average pollen size is 19.35 μm .



Pl. 1. — Chromosome numbers in 13 species of *Cassia* : 1, *C. alata*, $n = 14$, metaphase ; 2, *C. bicapsularis*, $n = 9$, metaphase ; 3, *C. fistula*, $n = 14$, anaphase I ; 4, *C. hirsuta*, $n = 8 + 1B$, metaphase ; 5, *C. marginata*, $n = 11$, anaphase I ; 6, *C. multijuga*, $n = 8$, anaphase I ; 7, *C. nodosa*, $n = 14$, metaphase ; 8, *C. obtusifolia*, $n = 13$, metaphase ; 9, *C. occidentalis*, $n = 13$, metaphase ; 10, *C. podocarpa*, $n = 8 + 1B$, metaphase ; 11, *C. siamea*, $n = 18$, metaphase ; 12, *C. sieberiana*, $n = 14$, metaphase ; 13, *C. spectabilis*, $n = 14$, metaphase.

TABLE 1

SPECIMEN No.	TAXON	ACCESSION No.	LOCALITY	CHROMOSOME NUMBER		POLOIDY LEVEL
				<i>n</i>	<i>2 n</i>	
1	<i>Cassia alata</i> L.	<i>Husaini 07</i>	University Campus Benin	14		Tetraploid
2	»	» <i>02</i>	Evboneka Nifor Benin	14		Tetraploid
3	»	» <i>33</i>	University Campus Benin	14		Tetraploid
4	<i>C. bicapsularis</i> L.	» <i>32</i>	Adesuwa School Benin	9		Diploid
5	<i>C. fistula</i> L.	» <i>72</i>	Aigusowan Street Benin	14		Tetraploid
6	<i>C. hirsuta</i> L.	» <i>27</i>	Atakhia Street Benin	8 + 1 B		Diploid
7	<i>C. marginata</i> Roxb.	» <i>16</i>	Nifor Road Benin	11	16	Diploid
8	<i>C. multijuga</i> Rich.	» <i>26</i>	2nd East Circular Road Benin			Diploid
9	»	» <i>75</i>	Akenzua Street Benin	8		Diploid
10	<i>C. nodosa</i> Buch.-Ham. ex Roxb.	» <i>52</i>	Ihama Street Benin	14		Tetraploid
11	<i>C. obtusifolia</i> L.	» <i>28</i>	University Campus Benin	13		Diploid
12	<i>C. occidentalis</i> L.	» <i>25</i>	Second East Circular Benin	13		Diploid
13	<i>C. podocarpa</i> Guill. & Perr.	» <i>13</i>	Evboneka Nifor Benin	8 + 1 B		Diploid
14	»	» <i>18</i>	Boundary Road Benin	8		Diploid
15	<i>C. siamea</i> Lamk.	» <i>08</i>	Lagos Road Benin	18		Tetraploid
16	<i>C. sieberiana</i> DC.	» <i>49</i>	Third Avenue Benin	14		Tetraploid
17	<i>C.</i> »	» <i>60</i>	India College Benin	14		Tetraploid
18	<i>C. spectabilis</i> DC.	» <i>73</i>	Adesuwa School Benin	14		Tetraploid

***Cassia fistula* L.**

Native of India and introduced into West Africa and other tropical countries, medium size tree of 10-12 m high, flowers pale yellow in long pendulous racemes. It grows best in acidic soil with pH of 5.4.

At Anaphase-I, 14 chromosomes were counted (Pl. 1, 3). Meiosis and pollen formation are normal with filled pollen 98 % and the average grain size is 19.35 μ m.

Seed morphology (Pl. 2, 11) : Seed glossy light brown ; not puckered or pitted ; oval to oblong ; compressed, raphe absent ; $10 \times 6 \times 2.5$ mm, seed coat thin, smooth and tough ; a narrow dark line runs lengthwise ; hilum round, small but prominent with an out growth.

***Cassia hirsuta* L.**

An alien from tropical America and now established near habitat in rich soil with pH of 6.2. Plant is a spreading shrub of 2 m tall.

A haploid count of $8 + 1$ B (Pl. 1, 4) was made at M-I. One B-Chromosome was observed in only about 20 % of the cells. Pollen stainability is 97 % and average pollen size is 45.15 μ m.

Seed morphology (Pl. 2, 2) : Seed dull dirty green to brown ; small, ovate, not puckered or pitted ; compressed ; raphe absent ; $3 \times 2 \times 1.5$ mm, seed coat smooth to wrinkled and tough ; prominent lengthwise ridge to demarcate seed into two, hilum circular and prominent.

***Cassia marginata* Roxb.**

A medium size tree of 12 m height, with pendent branches and mauve coloured flowers. A rare introduction from Asia and thrives best in acidic soil with pH of 5.5.

Eleven chromosomes were counted at A-I (Pl. 1, 5). Filled pollen is 98 % with pollen size of 32.25 μ m.

***Cassia multijuga* Rich.**

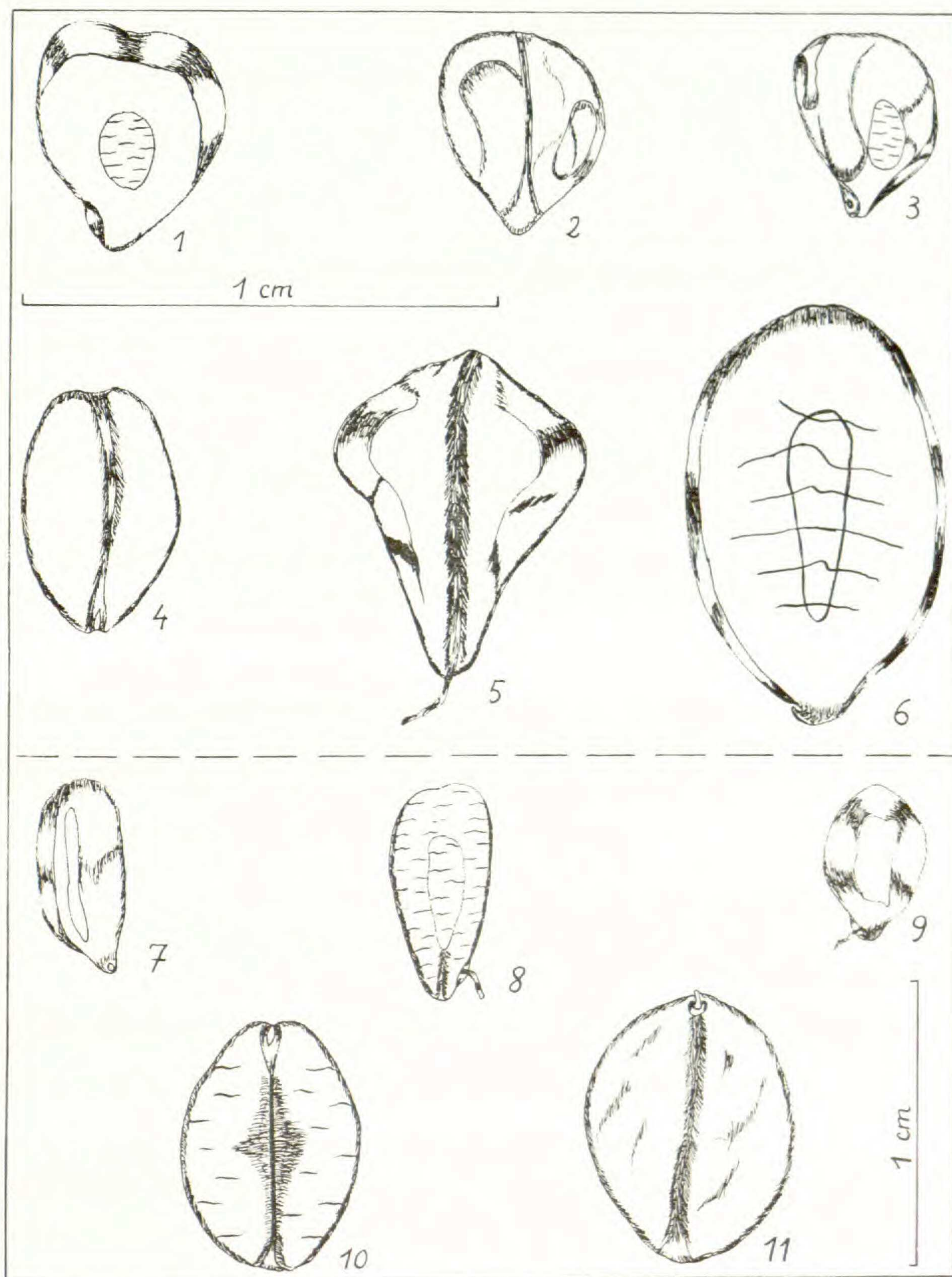
An alien from South America, medium sized tree of 8 m height, flowers yellow in erect panicles, commonly grown as an avenue tree. Grows best in neutral or slightly alkaline soil with soil pH of 7.5.

At A-I, 8 chromosomes were counted (Pl. 1, 6). Pollen formation and pollen fertility were normal with average pollen size of 25.8 μ m.

Seed morphology (Pl. 2, 3) : Seed dull grey, small, ovate, not puckered or pitted, raphe absent, $4 \times 3 \times 2$ mm ; seed coat smooth and tough ; an oval mark on the seed, hilum prominent at the tapering end in the apical notch.

TABLE 2 : PHENOLOGICAL DATA OF CASSIA SPECIES

TAXON	FLOWERING PERIOD	FRUITING PERIOD	POD LENGTH (cm) $\bar{X} \pm \text{S.E.}$	NUMBER OF SEEDS/POD $\bar{X} \pm \text{S.E.}$
<i>Cassia alata</i> L.	December-January	January-March	14.815 \pm 5.57	38.55 \pm 8.767
<i>C. bicapsularis</i> L.	Throughout the year	—	—	—
<i>C. fistula</i> L.	March-April	May-July	39.76 \pm 1.138	46.30 \pm 2.336
<i>C. hirsuta</i> L.	October-December	January-April	13.18 \pm 1.840	33.3 \pm 1.29
<i>C. marginata</i> Roxb.	July-September	September-November	—	—
<i>C. multijuga</i> Rich.	January-March	March-June	10.18 \pm 0.391	48.8 \pm 1.179
<i>C. nodosa</i> Buch.-Ham. ex Roxb.	February-May	June-August	44.17 \pm 3.65	64.7 \pm 5.924
<i>C. obtusifolia</i> L.	November-December	January-March	12.11 \pm 0.6455	13.4 \pm 2.246
<i>C. occidentalis</i> L.	March-May	May-August	10.075 \pm 0.310	40.5 \pm 1.815
<i>C. podocarpa</i> Guill. & Perr.	October-December	December-February	10.595 \pm 0.3094	16.35 \pm 1.63
<i>C. siamea</i> Lamk.	October-December	January-March	20.51 \pm 3.584	28.333 \pm 2.311
<i>C. sieberiana</i> DC.	January-March	March-July	64.00 \pm 3.1819	115.00 \pm 27.92
<i>C. spectabilis</i> DC.	Throughout the year	Throughout the year	20.62 \pm 1.90	18.6 \pm 0.866



Pl. 2. — Seed morphology in 11 species of *Cassia* : 1, *C. occidentalis* ; 2, *C. hirsuta* ; 3, *C. multijuga* ; 4, *C. sieberiana* ; 5, *C. alata* ; 6, *C. spectabilis* ; 7, *C. obtusifolia* ; 8, *C. podocarpa* ; 9, *C. siamea* ; 10, *C. nodosa* ; 11, *C. fistula*.

Cassia nodosa Buch.-Ham. ex Roxb.

A more widely cultivated species for its pink flowers in long erect racemes. It grows best in acidic soil with pH of 5.3.

A haploid number of 14 was counted at M-I (Pl. 1, 7). Filled pollen is 98 % and grain size is 25.8 μm .

Seed morphology (Pl. 2, 10) : Seed glossy to dull, light brown, ovate to oblong ; not puckered or pitted ; compressed ; raphe absent ; $3 \times 7 \times 2.5$ mm ; a narrow dark line runs lengthwise ; seed coat thin, smooth and tough ; hilum round and prominent.

Cassia obtusifolia L. (= *C. tora* L., F.W.T.A., 2nd ed., 1 (2) : 455, 1954).

A perennial shrub upto 3 m high with yellow flowers in terminal inflorescence. It grows in acidic soil with pH as low as 5.0.

Thirteen bivalents were counted at M-I (Pl. 1, 8). Meiosis and pollen formation were normal with 98 % filled pollen and average pollen size of 25.8 μm .

Seed morphology (Pl. 2, 7) : Seed dull light brown ; oblong, not puckered or pitted ; raphe absent ; $7 \times 3 \times 3$ mm ; seed coat rough, slightly wrinkled, and tough ; an elongated oval mark on the seed ; hilum small and on swollen tip.

Cassia occidentalis L.

An annual or perennial small shrub of 1 m height, flowers dark yellow in few flowered terminal racemes. Grows in acidic soil with soil pH of 6.4.

A haploid number of 13 (Pl. 1, 9) was counted at M-I. The % of filled pollen is 88 and grain size is 25.8 μm .

Seed morphology (Pl. 2, 1) : Seed dull greyish brown ; oval ; compressed ; not puckered or pitted ; raphe absent ; $5 \times 3.5 \times 2$ mm ; seed coat smooth and tough ; an oval mark on seed ; hilum prominent and circular.

Cassia podocarpa Guill. & Perr.

A shrub upto 5 m tall, flowers in dense racemes. It can grow in acidic soils with pH down to 4.7.

At M-I, $8 + 1$ B were observed (Pl. 1, 10). Pollen fertility is 98 % with grain size of 19.35 μm .

Seed morphology (Pl. 2, 8) : Seed glossy, brown to black ; ovate to oblong ; compressed ; wrinkled ; $7 \times 4 \times 2$ mm ; an oblong mark on the seed ; hilum small on the apical end of the seed.

Cassia siamea Lamk.

An alien from Indo-Malayan region, a medium sized tree upto 13 m tall with bright yellow flowers in both axillary and terminal racemes. Cultivated for wind-breaks. It grows in acidic soil with soil pH of 6.1.

Eighteen bivalents were counted at M-I (Pl. 1, 11). Meiosis and pollen formation were normal with 96 % filled pollen and the grain size is 25.8 μ m.

Seed morphology (Pl. 2, 9) : Seed dull, green to brown, oval to oblong, compressed, elliptical, not puckered or pitted ; raphe absent ; $5 \times 3.5 \times 1.5$ mm ; an oval mark on the seed ; a prominent line on lateral side of the seed ; seed coat smooth to wrinkled and tough ; hilum small.

***Cassia sieberiana* DC.**

A savannah tree upto 17 m tall with bright yellow flowers in large pendulous racemes. It can grow in very acidic soil with soil pH as low as 4.5.

A haploid count of 14 was made at M-I (Pl. 1, 12). Filled pollen is 98 % with pollen size of 25.0 μ m.

Seed morphology (Pl. 2, 4) : Seed glossy, light brown to dark brown ; ovate to oblong ; compressed, raphe absent ; $7-9 \times 5-6 \times 2.5$ mm ; prominent lengthwise line to demarcate seed into two ; seed coat streaked, thin, smooth and tough ; hilum small not prominent.

***Cassia spectabilis* DC.**

Medium sized tree, cultivated for its yellow flowers. Grows in acidic soil with soil pH of 5.7.

Fourteen bivalents were counted at M-I (Pl. 1, 13). Meiosis and pollen formation were normal with 93 % filled pollen and pollen size of 19.35 μ m.

Seed morphology (Pl. 2, 6) : Seed glossy, brown ; ovate to oblong ; thin and compressed ; not puckered or pitted ; raphe absent ; $8 \times 5 \times 1.5$ mm ; seed coat smooth ; an oblong mark on the centre of the seed ; a prominent line runs all around the peripheral regions ; hilum small and towards the tapering end of the seed.

DISCUSSION

Cytologically, *Cassia* is one of the most interesting genus as is exhibited by an array of recorded chromosome numbers for this genus (Vide FEDEROV, 1969, Index to Plant Chromosome number, 10PB Chromosome number reports 1-LX, and LÖVE & LÖVE, 1974).

New cytotypes have been reported here in *C. bicapsularis* ($n = 9$, authors ; $n = 14$, IRWIN & TURNER, 1960) ; *C. multijuga* ($2n = 16$, authors ; $n = 12$, IRWIN & TURNER, l.c.) ; *C. hirsuta* ($n = 8 + 1B$, authors ; $n = 14$, IRWIN & TURNER, l.c., FRAHM-LELIVELD, 1960) ; *C. siamea* ($n = 18$, authors ; $n = 14$, AITCHSON, 1951, TANDON & BHAT, 1970, DATTA & DATTA, 1972) ; *C. podocarpa* ($n = 8 + 1B$, authors ; $2n = 28$, FRAHM-LELIVELD, l.c.). The haploid chromosome number of 11 for *C. marginata* is recorded here for the first time. The intraspecific cytotypes are present in *C. alata* ($n = 14$, authors, PANTULU, 1960 ; $n = 12$, IRWIN & TURNER, l.c.), *C. fistula* ($n = 14$, authors, BIR & SIDHU, l.c., IRWIN & TURNER, l.c., MEHRA & HANS, 1971, MEHRA & SAREEN, 1973, NANDA, 1962, PANTULU, l.c., SAREEN & PARTAP, l.c., TANDON & BHAT, l.c., TISCHLER, 1922), *C. nodosa* ($n = 14$,

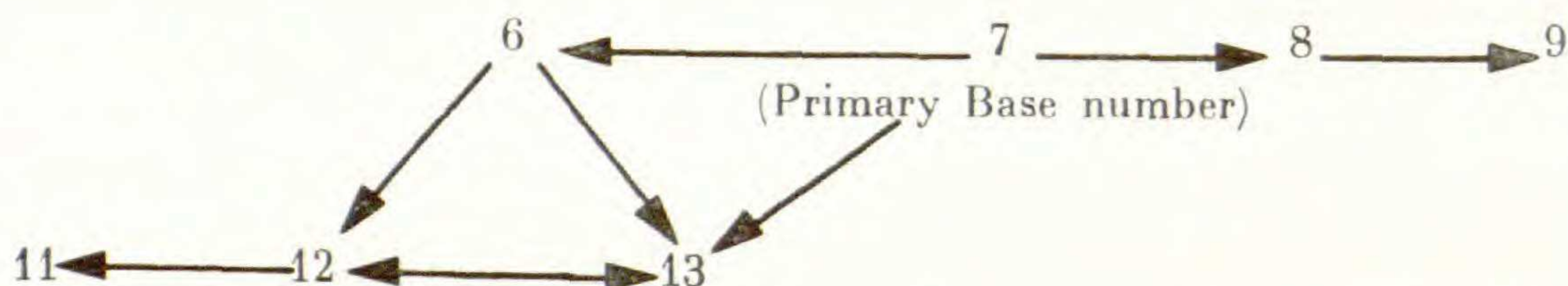
authors, MEHRA & HANS, *l.c.*, SAREEN & PARTAP, *l.c.*, TANDON & BHAT, *l.c.*; $2n = 24$, AITCHISON, *l.c.*, IRWIN & TURNER, *l.c.*), *C. obtusifolia* ($n = 13$, authors, BIR & SIDHU, *l.c.*, DATTA, 1933, TANDON & BHAT, *l.c.*, $n = 14$, JACOB, 1940, SAREEN & PARTAP, *l.c.*, TURNER, 1956), *C. occidentalis* ($n = 13$, authors, BIR & SIDHU, *l.c.*, MUTO, 1929, SINHA and PRASAD, 1972, $n = 14$, GILL, 1978, MIÈGE, 1962, PANTULU, *l.c.*, SAREEN & PARTAP, *l.c.*, SENN, 1938, TANDON & BHAT, *l.c.*, TURNER, *l.c.*), and *C. sieberiana* ($n = 14$, authors, MANGENOT & MANGENOT, *l.c.*, $2n = 26$, MIÈGE, *l.c.*). It is interesting to note that both cytotypes of $n = 13$ & 14 for *C. occidentalis* and *C. sieberiana* occur in West Africa.

DARLINGTON & WYLIE (1955) suggested the base chromosome numbers of 6, 7, 8 and 13 for *Cassia*. From the present investigations a new base number 9 is added to the already known numbers for *Cassia*. The present investigations along with the work of other authors provide information about the evolution of basic numbers in *Cassia*. Table 3 summarizes the total number of taxa based on each basic number.

TABLE 3

Base No.	6	7	8	9	11	13
No. of Taxa	4	106	30	2	2	9

From this table, it is evident that the majority of taxa are based on $x = 7$, followed with 8 as the next frequent number. IRWIN & TURNER (1960) suggested 7 as the primary base number for *Cassia* and the lower number of 6 might have been derived by reduction. Since an increase in the basic number is easier to envisage and is likely to cause less imbalance than a decrease (DARLINGTON, 1963), the base number of 8, 9, 11 and 13 might have been the result of increase in numbers. In angiosperms, base number of 10 and above are of secondary or polyploid origin (STEBBINS, 1950). So the higher base numbers 11 and 13 in *Cassia* might have arisen through polyploidy, followed by aneuploidy or dibasic polyploidy involving different base numbers. The hypothesis regarding the evolution of base numbers in *Cassia* may be illustrated as below :



Six of the 13 investigated species are tetraploids and of the seven diploids, three species are having secondary base numbers of 11 and 13. The grade of ploidy level in *Cassia* is fairly high as 8-ploidy has been reported in *C. potellaria* (KRAPOVICKAS, 1965). Apparently both polyploidy and aneuploidy have played a major role in the evolution of *Cassia*.

A perusal of the literature reveals that B-chromosomes were recorded only in 6 species of *Astragalus* (PODLECH & DIETERELE, 1969; FAVARGER, 1965), *Lespedizia* (1 sp., LEE, 1970), *Trigonella* (1 sp., RAGHVANSHI & JOSHI, 1968) and *Vicia faba* (SINGH & SINGH, 1966). The presence of B-chromosomes in *C. hirsuta* (8 + 1 B) and *C. podocarpa* (8 + 1 B) are recorded here for the first time.

Seed morphology for 11 species of *Cassia* are described from Nigeria for the first time. Seed varies in shape, structure and all investigated species have well developed pleurogram. Ecologically, majority of the investigated species grow in acidic soils.

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